REMARKS

In the last Office Action, the title of the invention was objected to as failing to be sufficiently descriptive of the invention to which the claims are directed. The Examiner pointed out that certified copies of applicants' corresponding Japanese patent application on which priority is claimed. Applicant notes that such will be filed at the time of payment of the issue fee herein.

Claims 1-7, 10, 11 and 13-16 were rejected under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 6,058,094 to Davis et al. ("Davis"). The Examiner stated that Davis discloses an information recording/reproduction apparatus in Figs. 1 and 4a-4b utilizing near field-light and comprising a light source 101 for generating light, a suspension arm 105, a flexure 130 fixed to the suspension arm 105, a near-field optical head 106 fixed to the flexure 130 and having a minute aperture formed therein, a substantially rod-like optical waveguide 102 having a core and a clad for conveying the light emitted by the light source through the core, a reflection surface 445 spaced apart from a terminal end of the core of the optical waveguide opposite the light source for irradiating light projected from the terminal end of the core to the near-field optical head, as shown in 4b, a recording medium 349 disposed proximate the near-field optical

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head, and a light reception portion for receiving scattered light caused by an interaction between the minute aperture and the recording medium, wherein the near-field optical head has a lens 446 formed on a surface thereof different from a surface on which the minute aperture is formed for focusing light received from the reflection surface onto the minute aperture, and the terminal end of the core is located at an intermediate part of the optical waveguide 102 so that the clad extends beyond the terminal end of the core.

The Examiner further stated that Davis discloses that the reflection surface 445 is a plane having an angle of about 45 degrees relative to the terminal end of the core (claims 2, 13) (citing col. 5, lines 37-41), that the terminal end of the core is shaped to form a lens (claim 3) (citing col. 6, line 65 to col. 7, line 5), that the reflection surface 445 is a plane formed to increase an expansion angle of a luminous flux projected from the terminal end of the core (claims 4-6 and 14) (citing Fig. 4b and col. 6, lines 24-32), that the flexure 130 supports the optical waveguide (claim 7), and that the clad of the waveguide extends beyond the end face of the core (claim 15) (citing Fig. 4b).

Applicants and applicants' undersigned attorney acknowledge with appreciation the indication of allowable subject matter with respect to claims 8, 9 and 12. However,

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for the reasons stated hereinbelow, applicants respectfully submit that claims of somewhat broader scope are allowable over the prior art of record.

By the present response, the title of the invention has been replaced by a new title which is more descriptive of the invention to which the claims are directed. Claim 1 has been amended in minor respects to inferentially recite a recording medium, which is not an essential component of the claimed near-field information recording/reproduction apparatus, and to further recite that the reflection surface is formed at a terminal end of the clad located beyond a terminal end of the core of the optical waveguide, and that the clad extends beyond the terminal end of the core to the reflection surface. Claim 10 has been amended in similar respects.

Applicants respectfully submit that claims 1-7, 10, 11, and 13-16 also patentably distinguish over the prior art of record.

The present invention relates to an information recording/reproduction apparatus utilizing near-field light, in which a near-field optical head is supported by a flexure fitted to a suspension arm and an optical waveguide conveys light from a light source to the near-field optical head. The waveguide comprises a substantially rod-like optical waveguide

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having a core and a clad for conveying the light emitted by the light source through the core, a reflection surface comprised of a terminal end of the clad located beyond a terminal end of the core opposite the light source for irradiating light projected from the terminal end of the core to the near-field optical head, and a light reception portion for receiving scattered light caused by an interaction between the minute aperture and a recording medium disposed proximate the near-field optical head.

Accordingly, amended independent claims 1 and 10 recite that the core of the optical waveguide terminates at an intermediate portion of the clad, the clad extends beyond the core, and the reflection surface is comprised of a terminal end of the clad.

In the embodiment illustrated in Fig. 1 of the application drawings, an information recording/reproduction apparatus has a near-field optical head 104 provided with a minute aperture for generating near-field light and is maintained in close proximity to the surface of a recording medium 105 which is rotated at a high speed. A flexure 108 is fitted to the distal end portion of a suspension arm 107 to cause the near-field optical head 104 to float while maintaining a predetermined orientation relative to the recording medium 105. The suspension arm 107 is moved in a

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radial direction of the recording medium 105 by a voice coil motor. The near-field optical head 104 is arranged in such a manner that the minute aperture opposes the recording medium 105.

To guide luminous flux from a laser 101 to the near-field optical head 104, an optical waveguide 103 that comprises a lens 102, and a core and a clad fixed to the suspension arm 107 is employed.

A light reception head 106 for reading the information recorded to the recording medium 105 is fitted to a suspension arm 109. The suspension arm 109 is fitted to the voice coil motor.

The waveguide and near-field optical head of the information recording/reproduction apparatus is illustrated in greater detail in Fig. 2 of the application drawings.

The near-field head 104 includes a micro-lens 205 formed on a transparent glass substrate, for example, and an air bearing surface 204 formed on the side of the recording medium so that the head 104 can always float while maintaining a predetermined relative orientation. A shading film converts the surfaces of the head 104 other that the surface on which the micro-lens 205 is formed. A minute aperture 106 is formed in the shading film on the bottom surface of the near-field optical head 104. The micro-lens 205 condenses the luminous

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flux from the optical waveguide 103 to the minute aperture 206. The waveguide 103 comprising the core 201 and the clad 202 is fixed to the upper part of the near-field optical head 104.

Figs. 3A and 3B illustrate the structure of the optical waveguide. The optical waveguide 103 comprises the core 201, the clad 202, and the reflection surface 203 for irradiating light to the near-field optical head 104 is formed at one of the end faces of the optical waveguide 103.

The core 201 of the optical waveguide 103 terminates at an intermediate part of the optical waveguide 103 such that an end face of the core faces the reflection surface 203. The region from the core end face to the reflection surface 203 is made of the same material as that of the clad 202 and/or has the same refractive index. The luminous flux propagating through the core 201 is dispersed by the medium having the same refractive index as that of the clad 202 on the end face of the core 201, and is reflected by reflection surface 203 as a divergent luminous flux having a certain expansion angle and irradiated to the near-field optical head.

The divergent luminous flux expanded as described above is condensed to the minute aperture 206 by the micro-lens 205 formed on the near-field optical head 104. Since the core 201 terminates at the intermediate part of the optical

waveguide 103, the distance from the core end face to the micro-lens 205 can be elongated and the radius of the luminous flux irradiated to the micro-lens 205 can be increased. Thereafter, the micro-lens 205 condenses the luminous flux to the minute aperture 206 and a high NA of the luminous flux incident into the minute aperture 206 can be attained. Since a high NA can be attained, the spot size of the luminous flux condensed to the minute aperture 206 can be decreased and the luminous flux having a high energy density can be thus irradiated. As a result, the intensity of near-field light generated in the proximity of the minute aperture 206 can be increased.

When a Fresnel lens is used as the micro-lens 205, a thin near-field optical head can be fabricated even when the lens diameter is increased. As the distance between the lens surface and the minute aperture is reduced, the NA of the luminous flux incident into the minute aperture can be further increased.

Thus, in accordance with the present invention, the reflection surface 203 is formed on one end face of the optical waveguide 103, and the core 201 of the optical waveguide 103 terminates at an intermediate part of the optical waveguide 103. Thus, the region from the core end

face to the reflection surface 203 is made of the same material and has the same refractive index as that of the clad 202.

No corresponding structure is disclosed or suggested by the prior art of record.

Davis discloses a flying magneto-optical head 106 of a magneto-optical data storage and retrieval system, which includes a slider body 444, an air bearing surface 447, a quarter-wave plate 493, a reflective substrate 445, objective optics 446, and a magnetic coil 460. The reflective substrate 445 comprises a reflective surface which is aligned at an angle of 45 degrees relative to the air bearing surface 447 and includes a steerable micro-machined mirror.

A single-mode PM optical fiber 102 is coupled along an axial cutout 443 of the slider body 444, and the objective optics 446 are coupled along a vertical cutout 411 at a corner of the slider body 444. Laser beams 191 and 192 traverse an optical path, to and from the surface recording layer 349 of the magneto-optical disk 107), that includes the single-mode PM optical fiber 102, the reflective substrate 445, the quarter-wave plate 493, and the objective optics 446.

In the absence of any disclosure of the core of the optical waveguide terminating at an intermediate portion of the clad, the clad extending beyond the core, and the

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reflection surface being comprised of a terminal end of the clad, anticipation of claims 1 and 10 under 35 U.S.C. §102 cannot be found. See, e.g., W.L. Gore & Associates v. Garlock, Inc., 220 USPQ 303, 313 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984) ("Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration").

As pointed out above, amended independent claims 1 and 10 recite that the core of the optical waveguide terminates at an intermediate portion of the clad, the clad extends beyond the core, and the reflection surface is comprised of a terminal end of the clad.

Davis fails to disclose these features of the claimed invention. The reflection surface 445 of Davis is not comprised of a terminal end face of the clad of the optical fiber 102. Furthermore, the core of the optical fiber 102 does not terminate an intermediate part of the optical fiber 102. Accordingly, Davis does not anticipate amended independent claims 1 and 10.

With respect to claim 3, although the Examiner pointed out that Davis discloses that the terminal end of the core is shaped to form a lens (citing col. 6, line 65 to col. 7, line 5), the shapes 601, 701 and 801 of the core 201 end face of the optical waveguide shown in Figs. 6-8 of the present application are not disclosed by Davis.

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Accordingly, applicants respectfully submit that claims 1-7, 10, 11, and 13-16 patentably distinguish over the prior art of record.

In view of the foregoing amendments and discussion, the application is now believed to be in condition for allowance. Accordingly, favorable reconsideration and allowance of the claims are most respectfully requested.

Respectfully submitted,

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May 5, 2004
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